

REPAIR OF THE URETHRA BY TRANSPLANTATION OF THE URETHRA OF ANIMALS.

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THE object of this paper is to describe some cases, three in number, in which patients with defects of the urethra have been treated by grafting into their tissues portions of the urethra of the ox.

Two of the patients so treated were men who had sustained a complete and extensive rupture of the urethra in the perineum; while the third was a boy with hypospadias, in whom there was a deficiency of the floor of the urethra for the whole of the penile portion of the channel.

It is not my purpose to enter fully and in detail into the various methods of treatment that have been proposed or adopted by different surgeons to effect a cure in similar cases; but it will be necessary to refer to some of these, and to say a few words regarding the condition of the parts which renders such methods of treatment necessary.

Complete transverse rupture of the urethra is an injury that, *per se*, may be associated with many complications of such grave importance as to elevate it to the rank of an accident of the first magnitude. These complications may be primary; in which case they are mainly dependent on the state of the urine at the time of the injury and its extravasation into the tissues around the rupture, or they are secondary, and in that case are associated with the healing process. For it may be laid down as an axiom that, unless the rupture is repaired by the union of urethral epithelium, a "splice" between the two portions of the canal by the formation of cicatricial tissue is unavoidable, so that the ultimate result to the patient is a stricture of the most intractable nature associated with all the ill effects of

backward pressure throughout the entire urinary tract posterior to it.

The question, therefore, as to the treatment required for this condition is one of great importance and of much practical interest.

In recent cases, provided that a large extent of the urethra is not actually destroyed by the contusing violence, the treatment is easy, and consists of exposing the ends of the two portions of the urethra and bringing them into accurate apposition by suture. Even in cases where a certain extent of the urethra is destroyed, the tissues which enter into the formation of the channel are so elastic as to permit of them being stretched over a considerable gap if they are sufficiently freed by dissection.

But there is difficulty in connection with these cases where the trauma has involved a considerable extent (length) of the urethral walls, or where sepsis has been followed by suppuration round the divided urethra; for by either of these processes necrosis of tissue is brought about and the suture of the two ends of the urethra rendered impossible or futile. Attempts to remedy the condition in such cases may be carried out on the following lines:

1. Guyon (*Gazette Hebdom.*, No. 20, 1892) advocates treatment of these cases by allowing the urethral tissues to regenerate from the two ends. He does not make any attempt to bring the ends together; they are merely freed from their surroundings; a soft catheter is passed into the bladder, and over this the tissues of the perineum are sutured: the catheter is allowed to remain in from two to four days, and after that time the patient is allowed to pass urine in the natural manner. It is claimed that from the ends of the urethra a regeneration of the mucous membrane will take place, and eventually line the channel formed between them by the suturing of the soft parts over the catheter.

Indeed, Ingianni (*Gaz. dell. Ospedale et della Clin.*, 1898, No. 127) (to whose original paper I have not access, though a brief quotation of it and the conclusions arrived at are given in

Centralb. für Chirurgie, No. 6, 1899) claims, from a series of experiments carried out on dogs,—

- (1) That a longer or shorter urethra can be produced.
- (2) That both mucous membrane and cavernous tissue are reproduced, but not muscular tissue.
- (3) That the reproduction takes place by the growth of a granulation tissue around the catheter from the ends of the urethra.

(4) It takes place faster where there is little postoperative inflammatory state.

(5) After fifteen to thirty days the new canal shrinks a little, but is only exceptionally obliterated.

Guyon in the above-mentioned paper briefly records three cases of traumatic stricture treated in this manner, but does not state what extent of the urethra was excised in any one of them. He makes the rather surprising statement that contact of urine, whether normal or pathological, does not harm the process of cicatrization. One would have thought that septic urine passing over a wound recently made and sutured would be liable to infect it.

2. By grafting the wound with skin or mucous membrane, the grafts being cut by Thiersch's method; or, by transplanting flaps of the same tissues.

Gersuny employed the latter method (transplantation) with apparently a good result (Report by Mrha, *Wien. klin. Wochenschrift*, 1898).

Wölfer (*Arch. klin. Chirurgie*, 1888) grafted a wound with the mucous membrane obtained from the vagina in a case of prolapse of the uterus, and the inner layer of the prepuce has been used by several surgeons for the same purpose (Meusel, Weir).

I believe that actually all these methods have been employed only in the treatment of cases of old standing and where a stricture of the canal was present. I am not aware of any case having been published where either line of treatment was made use of at a time when the case could be said to be "recent," i.e., before the urethra had been "spliced" by the

formation of an isthmus of cicatricial tissue between the two portions.

I have myself, however, treated with success a case of this kind by employing a skin flap; but skin does not appear to me to be a satisfactory material to employ for the purpose of making a channel to conduct urine. Skin is very easily irritated and inflamed by the constant bathing with urine. One has only to consider the effects on the skin of the scrotum and perineum in cases of incontinence of urine to be reminded of this fact.

Still, in some cases it may be the only tissue that one can employ, as in my case above referred to. Mucous membrane is probably a much better material for this purpose than skin, but is not always available at the time one requires it. In any case the employment of either of these substances entails at least two operations,—one for the purpose of making the graft, and a second for the conversion of the graft, after it has become adherent in its new situation, into a canal. It appeared to me, therefore, that, provided the grafts would live, it might be possible to treat these cases by implanting a portion of the urethra obtained from some animal; the advantage of this procedure being that not only was a complete channel obtained that could be buried in the tissues at one operation, but a channel lined with a mucous membrane prepared for conducting urine over its surface.

I have adopted this procedure on five occasions now in the cases of three patients, choosing for the purpose the urethra of a bullock, for, although the urine of the herbivora is alkaline, it was thought this factor might be neglected, as the difficulty of obtaining a urethra of a satisfactory diameter from an animal secreting acid urine is very considerable.

The following are the notes of the cases:

CASE I.—J. C., aged fifty-one years, but looks at least ten years older, was admitted to my ward in the Glasgow Royal Infirmary about midnight, December 2, 1900, on account of retention of urine.

He has been a heavy drinker, and was intoxicated at the onset of the retention two days before admission, since then only very small quantities of urine have been passed. A medical man had seen him on two occasions, and each time tried to pass soft instruments into the bladder, but failed to do so. On the day of admission the penis began to swell and no urine had been passed. On admission he was very exhausted, the penis was slightly swollen, the prepuce œdematous; at the penoserotal junction the tissues had a slightly bruised appearance, the prostate was not abnormally large, the bladder reached to the umbilicus.

An instrument could not be passed into the bladder; at a point two inches from the meatus an obstruction was encountered which was impassable, so the bladder was aspirated and a large quantity of blood-stained urine drawn off. The following morning, on palpating the parts, I found a crackling sensation in the tissues at the penoserotal junction, so made a free incision there, but the tissues only appeared to be bruised. Another incision was made in the perineum and a cavity opened into, which contained foul-smelling blood and urine, and the condition of the tissues was suggestive of traumatic rupture of the urethra. I could not find the proximal end of the urethra, so made a suprapubic cystostomy, washed out the bladder, which contained ammoniacal urine and blood, and passing a bougie from the bladder into the urethra found the latter to be destroyed from the apex of the prostate forward to the level of the triangular ligament, at least. I was still unable to pass an instrument through the penile urethra, but, hoping that the incision made there would relieve tension, I did not persist in the attempt. The wounds were dressed with moist dressings and the bladder drained by Cathcart's siphon apparatus. The discharge continued very offensive, and it was soon obvious that a large amount of tissue had sloughed, so the scrotum was split in the middle line, and it was found that the corpus spongiosum was completely gangrenous from the triangular ligament to a point five centimetres from the meatus of the urethra; this was all cut away, and a very large wound was left with a correspondingly large gap in the urethra; only the prostatic portion and a piece five centimetres long at the other end remaining.

The patient improved rapidly after this, and I decided to attempt to supply the defect in the urethra by a graft. This was done January 14, 1901. A portion of the penis of a young bullock

just killed was obtained at the slaughter-house and conveyed to the Royal Infirmary in hot sterile saline solution; the urethra was dissected out, leaving only a few alveoli of spongy tissue attached to it.

The patient's wound was then prepared, the ends of the urethra freed sufficiently to enable them to be sutured to the graft, and a portion of the bullock's urethra thirteen centimetres in length stitched in position. The wound was closed by buried and superficial stitches. It all healed absolutely by primary union except at the junction of the graft with the remaining portion of the penile urethra, there these two failed to unite, and a fistula resulted.

February 2, 1901, nineteen days after the implantation, I passed a No. 6 English bougie through the implanted urethra into the bladder easily, then freshened and sutured the ends of the urethra at the fistula again. Several times after this operation (although it was not intended that he should do so) urine was passed along the whole length of the urethra; but eventually the sutured part broke down again, and this was followed by some narrowing of the "graft" at the penoserotal junction, so on March 26, 1901, I split the scrotum again, dissected out the most distal part of the graft, and implanted (a second time) 7.5 centimetres of a bullock's urethra obtained as on the former occasion: it all remained viable, and the wound healed perfectly, but the junction of the new graft with the (original) penile urethra again failed, and, although it was operated upon several times and always held for a time, it always gave way eventually.

He was finally dismissed July 23, 1901, passing all the urine by the fistula, but able to do so in the erect attitude. Since then he has been seen from time to time; he can retain urine from one and a half to two hours, and has complete control of the bladder. He passes urine through the whole length of the implanted urethra.

During 1903 he has had several attacks of retention of urine, due, I think, to the state of his bladder rather than to that of the urethra, for we can always get a catheter into the bladder with ease.

A second case was treated in a similar manner last year.

CASE II.—L. S., aged twenty-eight years, admitted to the Glasgow Royal Infirmary, August 1, 1903, late at night. At about

9 A.M. that day he fell on the footplate of a locomotive, striking his perineum; he bled freely from the meatus, and shortly after the injury attempted to pass urine; none came by the meatus, but he was seized with intense pain and fainted. A medical man saw him shortly afterwards, and attempted to pass an instrument into the bladder, but failed.

On admission the patient was a good deal collapsed; blood was oozing slowly from the meatus; there was no sign of bruising or even of fulness in the perineum, but he complained of intense pain there on the slightest pressure. His bladder was distended to about half-way to the umbilicus.

Under anaesthesia I attempted to pass a full-sized instrument into the bladder, but could not get it beyond a point corresponding to the perineoscrotal junction, so I incised the perineum and opened into a large cavity full of blood-clot; the greater portion of the membranous part of the urethra appeared to have been destroyed, and I could not find the proximal end of the urethra, so was obliged to open the bladder above the pubis. A bougie was passed from the bladder, and it was found that the urethra terminated about half an inch in front of the apex of the prostate.

The wound was dressed wet in case it had been infected with the urine, and the bladder drained by a Cathcart siphon.

August 3, 1903. His temperature has been 101° F. or thereabouts all the time, but the perineal wound looked very well; and to-day I freed the distal portion of the urethra and just managed to suture it to the end of proximal portion and closed the wound; but his temperature kept up and the wound broke down; the bladder showed signs of infection even before the wound did (the patient stated that to his knowledge he had no urinary symptoms before his accident, but his bladder condition had made me suspicious from the beginning).

By the end of August, after constant dressing, the perineal wound was clean, but there was a gap of fully five centimetres between the ends of the urethra, and I determined to try and supply the defect by implanting a portion of animal urethra. On September 3, five centimetres fully of the urethra of a young bullock obtained immediately after the animal had been killed were implanted, its ends being sutured to the extremities of the urethra and the wound closed.

The wound healed perfectly, except one minute point just

behind the scrotum; but on September 14, 1903, a No. 7 English bougie was passed easily from the meatus to the bladder. The bladder condition had improved very greatly by this time.

September 21, 1903. He had a sudden desire to pass urine, although the siphon is still in use and some ounces of urine were passed per urethram. No. 7 has been passed every second day easily.

September 23, 1903. His temperature, which has been normal for the last three weeks, rose to-day to 102.4° F. and he vomited, and complained of pain in the region of the right kidney, but on palpation there was no swelling to be felt, though the region is tender. He got rapidly worse, and a swelling having developed in the region of the right renal, my friend Mr. Luke, to whom, for his invaluable assistance at these, and all my operations, I am continuously indebted, in my absence performed a nephrotomy and evacuated a good deal of pus from the kidney, but the patient did not improve; he gradually became comatose and died September 29, 1903.

At the post-mortem examination it was found there were numerous small abscesses in the cortex of the right kidney, mostly arranged in groups. The pelvis of the kidney contained several small calculi, and the right ureter was blocked by a calculus just above the level of the pelvic brim. The left kidney and ureter were healthy.

CASE III.—*Penile Hypospadias treated by Grafting a Portion of a Bullock's Urethra.*

A boy, aged fourteen years, was admitted to the Glasgow Royal Infirmary, January 13, 1902. The penis is greatly curved downward, the urethra terminates just anterior to the penoscrotal junction, and all the urine issues here. He is obliged to sit down to pass urine, owing to the curved condition of the penis: the line of the penile urethra is occupied by many little tags of skin. There is no frenum and no meatus in the glans.

January 30. After making a perineal fistula, the tags of skin were all cut away and the incision extended well into the substance of the erectile tissue, the fibrous sheath of which along with the skin was dissected back at each side as a flap. The penis could now be quite straightened. Seven centimetres of a bullock's urethra treated as in the other cases were then sutured into the groove made in the penis and to the freshened end of the urethra

posteriorly,—in front it was sutured to the margin of the incision in the glans and the wound closed over it.

It all healed except at the junction of the original urethra and the graft.

March 2, 1903. I passed a No. 3 English bougie the whole length of the urethra into the bladder and also closed the fistula, but this failed, and so did a second attempt. The patient about this time had several epileptic fits, which we found he had suffered from before admission.

His friends now removed him from hospital, and would not permit further treatment, but up to the time he left I could pass a No. 4 bougie from the meatus into the bladder.

He was not seen again until September 18, 1903, when he came back anxious for further treatment. Most of the urine was passing by the perineal fistula, but some also came by the opening in front of the scrotum. A small part of the implanted urethra was seen to be still present and admitted a small bougie, but the meatus was closed.

September 5, 1903. I dissected out the cicatrix of my former operation, cutting well into the erectile tissue, and found that practically the whole of the former graft was not only intact, but permeable. I excised the whole of it, and then implanted fully nine centimetres of a recently killed bullock's urethra, suturing it to the end of the urethra posteriorly and the margin of the glans in front, and closed the wound completely. The graft lived, and the wound healed perfectly except at the junction of the graft with the original urethra at the penoscrotal angle. He had many fits after the operation, which made it a still more difficult matter to keep the penis steady. At the beginning of December I closed the defect at the penoscrotal angle and was able to pass a No. 8 English bougie all the way to the bladder. This operation was successful, and he went out December 29, 1903, after having been taught to pass a bougie himself.

He has been seen frequently since. A No. 6 can be passed easily.

The treatment of these three patients represents five operations in which portions of an animal's urethra, varying in length from five to thirteen centimetres, have been implanted with success, that is to say, the grafted tissue lived and remained

a patent channel. It is true that in two of the patients the procedure required to be done a second time, but in each of them, at the time of the second operation, the tissue which had been grafted on the former occasion was found to be present.

The Figure appended—a microphotograph (for which I am indebted to my friend, Dr. T. H. Bryce) of a section of the graft excised from R. M. after being in the tissues of the penis for nineteen months—shows a perfect canal lined by a normal layer of epithelium.

It was the penile region which gave the trouble in the two patients (J. C. and R. M.), and this was due to the extreme difficulty there is in adequately maintaining this part in a state of rest. Further, in the case of R. M., we had the recurring epileptic seizures as an additional source of disturbance of the parts.

But where the graft was placed in the perineal region the result was excellent. In the specimen obtained at the post-mortem examination of L. S., it is hardly possible to make out the line of union of the mucous membrane of the graft with that of the original urethra, the channel is so smooth.

So far as I am aware, the procedure constitutes a new method of treating hypospadias; in fact, it was in connection with a case of this kind which I saw nine years ago that the idea of attempting a graft in this way occurred to me, but the patient—an adult—declined any operative proceeding, and I had no opportunity of carrying it out until J. C. came under my care in December, 1900.

Every method of treating hypospadias by operation is uncertain as to the result; for, as in all plastic operations, there is the liability of flaps to slough or of sutures to give way before union has completely taken place; a fistula frequently results somewhere along the course of the new canal. One reads continually in the reports of such cases that before a cure has been effected several operations have been necessary.

This method of implanting a true urethral tube is at least as certain as any other that has been suggested, while the advantage of having a canal ready made, which can be obtained in



Transverse section of the urethral canal excised from Case III nineteen months after implantation.

unlimited quantity and which has been developed for the actual purpose of transmitting urine, is a very great one. And for the same reason it is, I believe, greatly superior to the methods hitherto employed in the treatment of those deficiencies of the urethra which result from traumatic rupture.

A case was recorded in the *Lancet*, Vol. i, 1896, by Clennell Fenwick, in which a portion of a sheep's urethra (the length is not stated) was transplanted in a case of intractable stricture, but I cannot find any other.